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ASYMMETRIES IN LANGUAGE USE REVEAL ASYMMETRIES IN THE GRAMMAR

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According to the classical view, the nature of the grammar is independent of its use. A puzzle for this view is the observation that in language acquisition production sometimes precedes comprehension. Children who use subject-object status to determine word order in production not necessarily use word order to determine subject-object status in comprehension. On the basis of results from first language acquisition as well as adult sentence processing, we show that the role of grammar in production can be different from the role of the same grammar in comprehension.

1. Asymmetry in Language Acquisition

If children produce a particular form correctly, they seem to know the relevant grammatical rules. But if they know the relevant grammatical rules, they should be able to use these rules in comprehension too. However, children's performance in production and comprehension sometimes diverges, suggesting an asymmetric grammar. The aim of this paper is to provide additional evidence for such an asymmetric grammar and discuss the properties of this grammar.

A remarkable asymmetry in language acquisition has been found with word order in English. In an experiment with 15 children (1;8-2;8), Chapman and Miller (1975) found that in production these children tend to preserve subject-object order. In 83.7% of the cases with two animate actors, children produced forms such as "boy hit girl" or "hit girl", rather than "girl hit boy" or "hit boy", when having watched the action of a boy doll hitting a girl doll. However, these same children, when tested on the same type of sentences in a comprehension experiment, significantly less often (in 66.5% of the cases) used word order information as a cue to subject-object status. These children frequently demonstrated the action expressed by the sentence *The boy is hitting the girl* with the girl doll hitting the boy doll. Apparently, for a young child this sentence can mean both "boy hit girl" and "girl hit boy". A similar asymmetry between production and comprehension was found by McClellan, Yewchuk and Holdgrafer (1986) in their replication of

Chapman and Miller's experiment. These observations are further supported by the frequent occurrence of inversion errors in acquisition experiments on anaphora comprehension in e.g. Dutch, reported by Koster (1993).

To account for the observed production/comprehension asymmetry within the grammar, a theory of grammar is required that distinguishes between the hearer's task and the speaker's task. Optimality Theory (henceforth OT, Prince and Smolensky 2004) provides such a theory. In OT, it is assumed that language users select the best output for a given input on the basis of optimization over an ordered set of violable constraints. In production, the input is a meaning and the output the optimal form for that meaning. In comprehension, the input is a form and the output the optimal meaning for that form. In section 2 we show how OT can account for the pattern found by Chapman and Miller.

2. PRECEDENCE and PROMINENCE

Several off-line and on-line experiments in English and Dutch have proven that besides word order, animacy is an important source of information in comprehension (e.g., McDonald 1987). In their study of animacy in sentence comprehension, de Hoop and Lamers (to appear) propose a set of five violable constraints that serve the purpose of distinguishing the subject from the object in transitive sentences. The following two constraints seem to be relevant to the analysis of Chapman and Miller's findings:

- (1) PRECEDENCE: The subject precedes the object.
- (2) PROMINENCE: The subject outranks the object in prominence (here, animacy).

In English (in contrast to, e.g., Japanese), PRECEDENCE is a very strong constraint which results in the ungrammaticality of an OVS order. We hypothesize that the young children in Chapman and Miller's experiment do have the two relevant constraints in their grammar, but have not acquired the right ranking yet.

To test children's comprehension, Chapman and Miller used the four types of sentences illustrated in (3). For each of these sentences, in principle two interpretations are possible, a subject-before-object (SO) and an object-before-subject (OS) interpretation. Adults invariably arrive at the SO interpretation, irrespective of the animacy properties of the arguments, thereby providing evidence for the strict dominance of PRECEDENCE over PROMINENCE in English.

- (3)
 - a. The boy is hitting the girl. (+animate; +animate) SO – OS
 - b. The car is hitting the boy. (-animate; +animate) SO – OS
 - c. The girl is hitting the car. (+animate; -animate) SO – OS
 - d. The car is hitting the boat. (-animate; -animate) SO – OS

For young children, the constraint ranking is not so clear yet. For them, animacy might be a more important cue than word order when comprehending a transitive sentence. Following de Hoop and Lamers (to appear), we assume that a combination of two animate or two inanimate nouns violates PROMINENCE once, since the subject does not outrank the object in animacy. PROMINENCE is violated twice if the object outranks the subject (that is, if the object is inanimate and the subject is animate). Finally, PROMINENCE is satisfied if the subject is animate and the object is inanimate. When children have PROMINENCE high-ranked, we therefore expect them to perform best on comprehending sentences with an animate subject and an inanimate object, and to experience most problems when it is the other way around. Chapman and Miller indeed found this pattern in comprehension, with children performing best (93.8%) on sentences like (3c), intermediate (66.5% and 65.2%, respectively) on sentences like (3a) and (3d), and worst (50.1%) on sentences like (3b). The pattern can be illustrated in an OT semantic tableau (Hendriks and de Hoop 2001), where the input is a form as in (3a-d) and the output is a meaning (SO or OS):

- (4) OT semantic tableau: from form to meaning

Input: form		Output: meaning	PROMINENCE	PRECEDENCE
(+anim; +anim)	☞	SO interpretation	*	
		OS	*	*
(-anim; +anim)		SO	**	
	☞	OS		*
(+anim; -anim)	☞	SO		
		OS	**	*
(-anim; -anim)	☞	SO	*	
		OS	*	*

This tableau predicts that children with the wrong ranking (PROMINENCE >> PRECEDENCE) arrive at the right interpretation of a sentence with an animate subject and an inanimate object, but at the wrong interpretation when the sentence contains an inanimate subject and an animate object. This is basically in accordance with the percentages found by Chapman and Miller. Their interpretations of sentences with two animate or two inanimate arguments are slightly more difficult to explain. In these cases, we expect the SO interpretation to emerge as the optimal interpretation because PROMINENCE cannot make a difference here. But in around 35% of the cases the children get a OS reading. These deviations may be due to the fact that PROMINENCE is actually about discourse prominence rather than about animacy per se. Other factors may influence the perceived prominence relation between the two arguments, such as

visual cues and world knowledge (cf. McClellan et al. 1986). Furthermore, children may initially attend to one or two factors only, rather than to the entire set of factors involved in determining prominence. For these reasons, we expect children to show some variation. Yet, the general pattern seems clear and we can analyse the basic findings in terms of the two constraints and children's reversed ranking of the two.

Recall that our grammar distinguishes the hearer's task from the speaker's task. Which knowledge do English children need to produce the correct word order for a transitive sentence? We claim that production can be modelled by the same grammar as comprehension, i.e., by the same two constraints under the same ranking:

(5) OT syntactic tableau: from meaning to form

Input: meaning	Output: form	PROMINENCE	PRECEDENCE
(+anim; +anim)	☞ SO word order	*	
	OS	*	*
(-anim; +anim)	☞ SO	**	
	OS	**	*
(+anim; -anim)	☞ SO		
	OS		*
(-anim; -anim)	☞ SO	*	
	OS	*	*

In the tableau in (5), the input is the event meaning, with the elements between brackets referring to the order of agent and patient. There are two candidate outputs: SO and OS word order. These two forms are evaluated against the two constraints PROMINENCE and PRECEDENCE. However, PROMINENCE is a vacuous constraint in production. When the child wishes to express a given event with particular animacy properties, PROMINENCE is violated or not, irrespective of the word order. Hence, the only constraint that plays a role in production is the word order constraint PRECEDENCE. Therefore, the SO word order is the optimal output for all inputs under both constraint rankings. This straightforwardly explains why all children, also those who do not have the right constraint ranking yet, perform adult-like in production.

3. Evidence from Sentence Processing

We have argued that the interaction of two constraints, PROMINENCE and PRECEDENCE, predicts the observed asymmetry in language acquisition. In this section we provide evidence that PROMINENCE plays a role in adult's comprehension as well. In German, like in English, PRECEDENCE outranks PROMINENCE, but OS word order is not

ungrammatical. Because the constraint CASE (de Hoop and Lamers to appear) outranks PRECEDENCE, the OS interpretation is optimal if the first NP bears accusative case.

Although PROMINENCE is low-ranked in German, evidence from German suggests that a violation of PROMINENCE is associated with a significant effect in brain activity. Consider the following (incomplete) indirect questions, which are *ungrammatical* because they contain two nominative NPs, while one should have been accusative:

- (6) *... welcher Bischof ... der Priester
... [which bishop]_{NOM} ... [the priest]_{NOM}
(7) *... welcher Bischof ... der Zweig
... [which bishop]_{NOM} ... [the twig]_{NOM}

Frisch and Schlesewsky (2001) found a clear effect in brain activity (a so-called N400 effect) at the second NP in (6) which was lacking in sentence (7). This indicates that people have more problems with processing sentence (6), which contains two animate NPs, than with sentence (7), which combines an animate and an inanimate NP. Because the two sentences differ in the animacy of the NPs, they differ with respect to PROMINENCE. PROMINENCE can be satisfied in (7) (by taking the animate NP as the subject) but never in (6). A similar N400 effect arises at the position of the second NP in the *grammatical* indirect questions in (8) and (9) (Schlesewsky and Bornkessel 2004):

- (8) ... welchen Bischof der Priester begleitete
... [which bishop]_{ACC} [the priest]_{NOM} accompanied
(9) ... welchen Bischof der Zweig streifte
... [which bishop]_{ACC} [the twig]_{NOM} brushed

In (8), PROMINENCE is violated once because subject and object are equal in animacy and hence the subject does not outrank the object. In (9), on the other hand, PROMINENCE is violated twice because the object in fact outranks the subject in animacy. The N400 for sentence (9) compared to sentence (8) thus corresponds to a worse violation of PROMINENCE under the optimal (OS) interpretation, which satisfies the higher ranked constraint CASE. Thus, although adults are not expected to show any production/comprehension asymmetries because they have established the right ranking of the constraints, we do seem to find effects of violations of PROMINENCE with adults as well, namely in their processing of animacy differences.

4. Conclusion

On the basis of evidence from first language acquisition we argued that the non-adult

ranking of two violable constraints, PRECEDENCE and PROMINENCE, accounts for the production/comprehension asymmetry with respect to basic word order displayed by young children. Only under the adult ranking does the adult pattern of non-ambiguous forms arise. That both constraints are still active in the adult's grammar, even when one strictly dominates the other, is supported by evidence from sentence processing. This result may have important consequences for our view of the grammar, since it suggests that the grammar is asymmetrical. When used in one direction only, the same set of constraints may generate ambiguity in comprehension, yet no optionality in production.

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